Universität Basel

Department of Biomedical Engineering

Patient specific bioresorbable implants for cranio-maxillofacial applications

Till Strunk[1,2,3], Neha Sharma[1,2], Nadja Rohr[3] and Florian M. Thieringer[1,2]

[1]Medical Additive Manufacturing Research Group, Department of Biomedical Engineering, University of Basel, Allschwil, Switzerland

[2]Clinic of Oral and Cranio-Maxillofacial Surgery, University Hospital Basel, Basel, Switzerland

[3]Biomaterials and Technology, Department of Reconstructive Dentistry, University Center for Dental Medicine Basel UZB, University of Basel, Basel, Switzerland

Background

Implants made of inert materials provide great mechanical strength but can induce problems like stress shielding, infections or imperfect fit due to a changing anatomy. Thus, a second surgery is sometimes required extract these implants, causing an additional burden on patients and the health care system. Bioresorbable materials provide mechanical stability that is needed in the beginning but are resorbed by the body as bone tissue remodels and eventually replaces the implant. 3D printing in combination with CT imaging and organic CAD modeling softwares can be used to create patient-specific implants that offer a perfect fit to the defect.

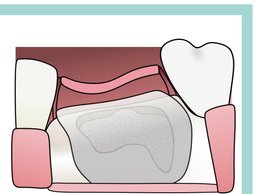
The objective of this dissertation is to create a workflow that allows for the clinical application of 3D printed, patient specific bioresorbable implants for cranio-maxillofacial (CMF) applications.

Materials & Methods

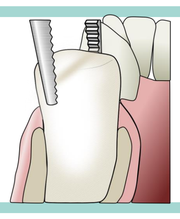
As a bioresorbable material, a commercially available mixed composite is used – consistent of Poly-(L-co-D/L-Lactid) (PLDLLA) and β-Tricalcium phosphate (β-TCP). To 3D-print, a freeformer 300-3x (Arburg, Lossburg, Germany) will be used to print dimensionally accurate solid and porous scaffolds. Subsequently, the scaffolds will be tested regarding, among others, dimensional accuracy, mechanical stability, susceptibility to sterilization, cell viability and degradation rate.

Bioresorbable CMF applications

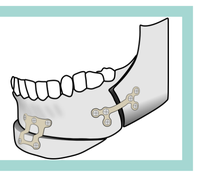
Guided bone regeneration mesh
Guided bone regeneration (GBR) is a surgery technique to grow alveolar bone. A mechanically stable mesh is needed to keep bone substitute material in place.



Bone graft
Can potentially help to augment alveolar bone mass or other onlays in a one step approach.



Osteosynthesis fixation plates
Help to fuse two disconnected bone sites.



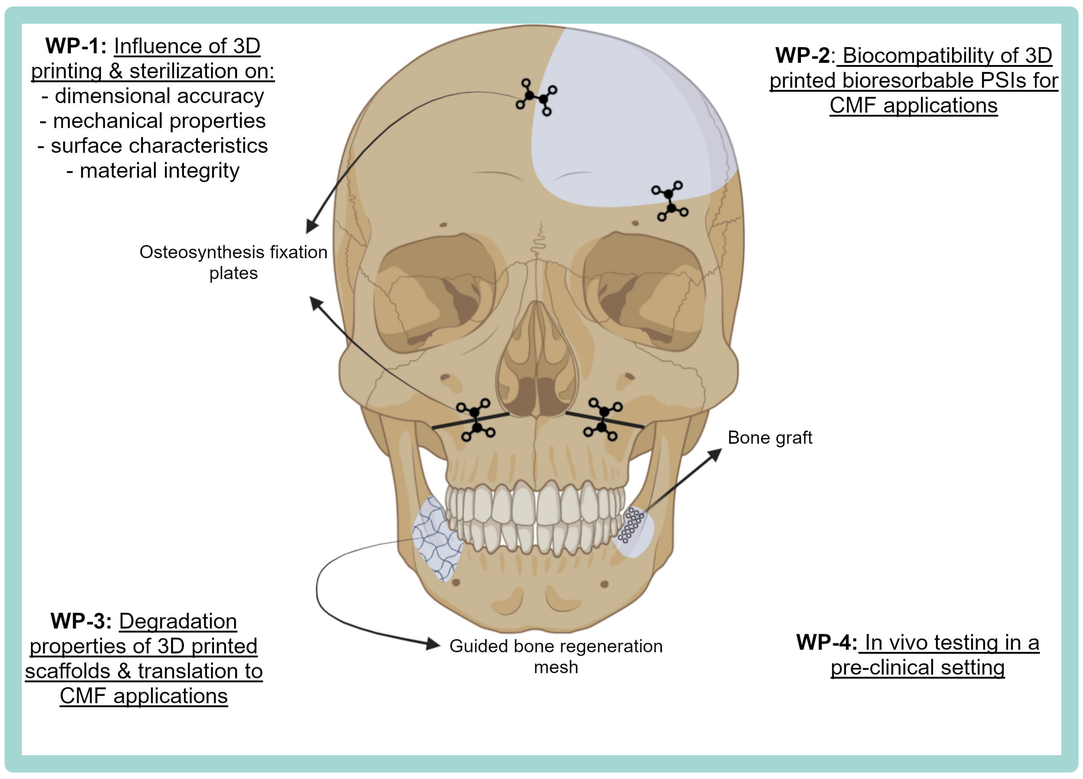
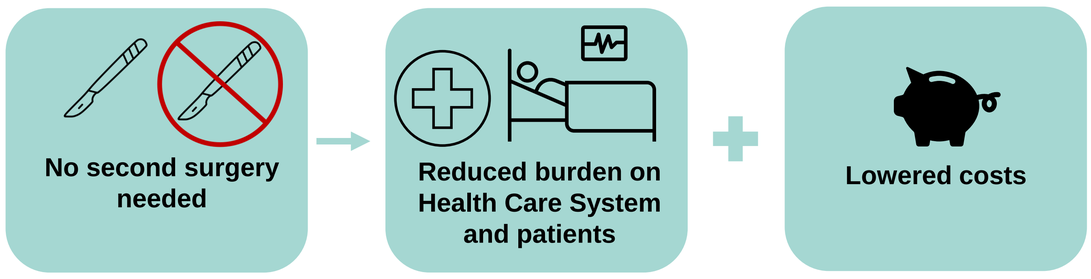


Figure 1: Graphical overview of the planned work packages and potential CMF applications.

Work package aims

1. **To explore bioresorbable materials, 3D printing parameters and investigate how sterilization procedures and printing influence characteristics like dimensional accuracy, surface characteristics and material properties.**
2. **To verify adequate in vitro biocompatibility with regards to bone and gingival tissue cell viability and hydroxyapatite adsorption.**
3. **To show that 3D printed bioresorbable implants degrade at a suitable rate for bone remodeling and report the mechanical properties over the course of degradation. Furthermore, 3D print previously mentioned CMF implants.**
4. **Pre-clinical study in rat calvarial defects.**

Possible benefits



Medical Additive Manufacturing Research Group, Department of Biomedical Engineering, University of Basel, Allschwil, Switzerland

Department of Oral and Cranio-Maxillofacial Surgery, University Hospital Basel, Basel, Switzerland

University Center for Dental Medicine Basel UZB, University of Basel, Basel, Switzerland

Website:

Universitäres Zentrum für Zahnmedizin Basel

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